THE UNIVERSITY OF NAIROBI

COLLEGE OF AGRICULTURE AND VETERINARY SCIENCES

DEPARTMENT OF FOOD SCIENCE NUTRITION AND TECHNOLOGY

INDUSTRIAL PROJECT REPORT

DEVELOPMENT OF FRUIT FLAVORED WINE FROM SUGARCANE JUICE USING DIFFERENT TYPES OF YEASTS

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT FOR THE REQUIREMENT OF THE AWARD OF DEGREE IN BACHELOR OF SCIENCE FOOD SCIENCE AND TECHNOLOGY

2014

DECLARATION

I declare that this project is my original work and has not been presented for degree in any other University.

Signed……..

Date ; 25/4/2014.

This report has been submitted for examination with approval as University supervisor.

Signed……

Date……

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ACKNOWLEDGEMENT

First I thank god for granting an opportunity to successfully carry out this project and seeing me through the entire academic journey.

I offer my sincere gratitude to Prof. S.K Mbugua, my supervisor for his invaluable advice and positive criticism during the execution of this project.

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ABSTRACT

Three yeasts strains (Bakers yeast *Saccharomyces cerevisiae*, Brewers yeast *Saccharomyces cerevisiae* – top fermenter and muratina yeast(obtained from the fruit of sausage tree *Kigelia aficanus*) were tested for their ability to ferment sugarcane (*Saccharum officinarum*) juice. The total acidity, pH, total sugars and °Bx tests for the juice were determined after which the juice was ameliorated to adjust the Brix and pH to the right wine concentrations. The fermentation was carried out at 18 °C for about two months after the juice was inoculated with 5% (v/v) suspensions of the yeasts containing 1×10^8 cells ml^{-1}. The wine was then subdivided into three batches and flavored using fruit flavors – banana and pineapple. These were then transferred to a cold room for maturing and sedimentation.

The samples were then subjected to sensory analysis and the data subjected to ANOVA analysis to determine the most preferred wine.

It was found out that bakers yeast had the best ferment ability resulting to the best wine and the banana flavored wines were preferred over the pineapple and unflavored wines. The fruit flavored wines were significantly preferred at ($P \leq 0.05$) over the plain product in all the three samples tested. This indicated that the elaboration of wine-like beverages is a good alternative use for sugarcane juice.

1.0 INTRODUCTION

Sugarcane is a tropical, perennial grass of the genus *Saccharum* that forms lateral shoots at the base to produce multiple stems, typically three to four meters high and about five cm in diameter. The stems grow into cane stalk, which when mature constitutes approximately 75% of the entire plant. A mature stalk is typically composed of 11–16% fiber, 12–16% soluble sugars, 2–3% non-sugars, and 63–73% water. The main product of sugarcane is sucrose, which accumulates in the stalk internodes. Sucrose, is extracted and purified in specialized mill factories, and is used as raw material for sugar production or is fermented to produce ethanol. Ethanol is produced on a large scale by the sugarcane industry.(FAO 2010)

There are 3 sugar belts in Kenya, namely the Nyando, the western sugar belt and the south Nyanza sugar zone. Sugar is the 2nd largest contributor to Kenya's agricultural growth after tea. The area under cane is 123,622 hectares of which 111,189 ha is farmed by smallholders and 12,433 under nucleus estates. Kenya's annual production ranges from 400,000 - 500,000 metric tons. Kenya produces on average 475,670 tons of sugar annually. The majority of sugar cane producers are small-scale growers, whilst the remaining area is largely under sugar factories in the form of nucleus estates.

Sugarcane juice is the juice extracted from pressed sugarcane. It is consumed as a beverage in many places, especially where sugarcane is commercially grown such as Southeast Asia, South Asia, Latin America and Brazil. The juice is obtained by crushing peeled sugar cane in a mill. It can be a hand cranked machine, or powered. It is served, often cold, and sometimes with other ingredients such as a squeeze of lemon or lime pineapple, passion fruit, ginger or ice.

Sugarcane juice is high in sucrose which can be utilized by yeast to form an alcoholic beverage. This study aimed at assessing the ferment ability characteristics of three yeast strains on the extracted sugarcane juice and aromatization using fruit flavors so as to determine efficiency of the yeasts and the acceptability of the wine obtained.

1.1 LITERATURE REVIEW

There is a wide range of alcoholic beverages obtained by the fermentation of sweet liquids (vegetable juices, honey, milk) but the most important are wine, beer and cider. Wine is an alcoholic beverage produced by the fermentation of the juice of fruits, usually grapes, although other fruits such as plum, banana, elderberry or blackcurrant may also be fermented and used to obtain products named "wine".Sugar cane juice has high readily fermentable sugars that provide a substrate for yeast conversion to wine. Internationally sugar cane juice is used in production of Basi e.g in the Philippines, commercial basi is produced by first crushing sugarcane and extracting the juice. The juice is boiled in vats and then stored in earthen jars. Once the juice has cooled, flavorings made of ground glutinous rice and java plum bark or other fruits or barks is added. The jars are then sealed with banana leaves and allowed to ferment for several years. The resulting drink is pale red in color. If fermented longer, it turns into *suka* or vinegar due to growth of *acetic acid* bacteria. **(**Abs-Cbn Interactive, Ilocanos mark 200 yrs. of Basi Revolt)

Most non commercial sugarcane produced by farmers has to be consumed locally. However once mature there is a high risk of postharvest losses. Sugar cane if left in the farms for long after maturity results to drying up due to juice evaporation hence affecting sucrose recovery. Harvested cane has also to be consumed or processed immediately to avoid sucrose inversion as well as drying up due to juice evaporatioin.(***Problems and Prospects of Sugar Industry* - Rakesh Chandra**)

1.2 PROBLEM STATEMENT.

Most non commercial sugarcane produced by farmers has to be consumed locally. However once mature there is a high risk of postharvest losses. Sugar cane if left in the farms for long after maturity results to drying up due to juice evaporation hence affecting sucrose recovery. Harvested cane has also to be consumed or processed immediately to avoid sucrose inversion as well as drying up. To avoid this there is need for value addition to the cane. Eg conversion to an alcoholic beverage.

Muratina is produced locally using sugarcane juice . However, the beer is too sour due to high acidity thus limiting the product acceptability due to the muratina yeast(obtained from the fruit of sausage tree *Kigelia aficanus*) converting some of the sugars into gluconic acids. There is need to determine a good yeast strain which can be used to produce a more acceptable product

1.3 JUSTIFICATION

Sugar cane juice also has a high concentration of readily fermentable sugars- (18-23 brix) that will provide a substrate for yeast fermentation to alcohol. There is plenty of sugar cane produced locally that's lost through postharvest losses. Value addition to the sugar cane can help reduce these losses through juice extraction and fermentation of the juice. This will result to an alcoholic product that is more stable and hence a longer shelf life.

The type of yeast used during the fermentation process will have an influence on the product obtained since each variety has specific optimum conditions for wine production. The flavors will also affect the flavor and aroma of the different wines obtained from the yeast and hence its expected that they will influence the product acceptability.

This study therefore aims at determining the best variety of yeast in sugarcane wine production and the flavor which when used will have the greatest influence on the product acceptance.

1.4 MAIN OBJECTIVE

To produce fruit flavored sugar cane wine using brewers, muratina and baker's yeast.

1.5 SPECIFIC OBJECTIVES

- Adjustment of the sugar content and titratable acidity of the extracted juice
- Aromatization of the wines obtained using fruit flavors.
- Comparison and assessment of the acceptance of the products.
- Analysis of the assessment data.

2.0 EXPERIMENTAL DESIGN

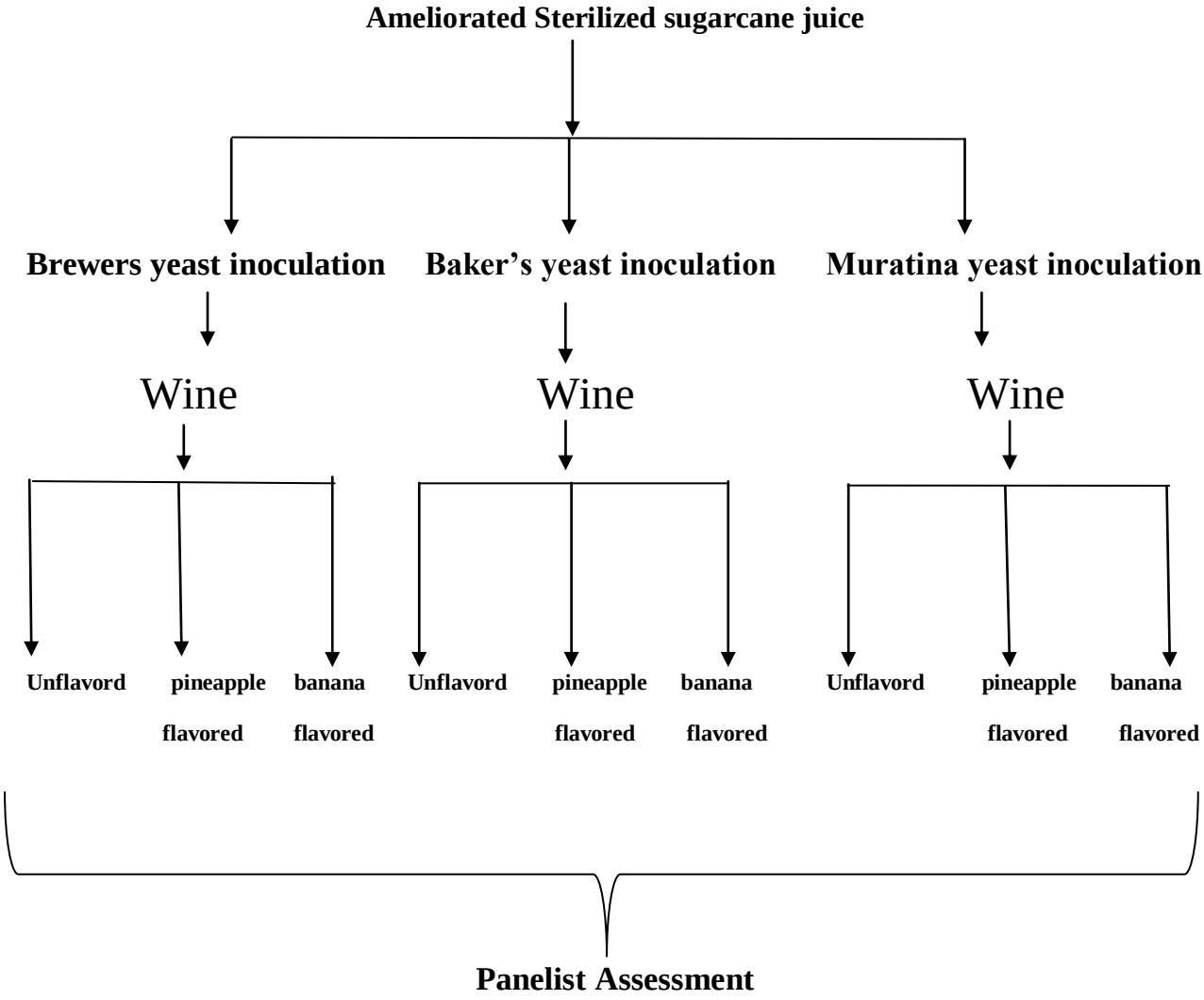
Three yeasts will be tested for their ability to ferment sugarcane (*Saccharum officinarum*) juice. In order to do this, time course studies of volatile, fixed, and total acidity, pH, alcohol, total sugars and °Bx will performed. The fermentation studies will be carried out and the juice inoculated with 5% (v/v) suspensions of the three yeasts containing 1×10^8 cells ml^{-1} and left to ferment to completion with the above parameters being measured at intervals during fermentation. The wine obtained will then be flavored with the fruit flavors Three yeasts will be tested for their ability to ferment sugarcane (*Saccharum officinarum*) juice. In order to do this, total acidity, pH, alcohol, total sugars and °Brix were determined. The fermentation studies will be carried out and the juice inoculated with 5% (v/v) suspensions of the three yeasts containing 1×10^8 cells ml^{-1} and left to ferment to completion with the above.0.

The wine obtained will then be flavored with the fruit flavors. The resulting product will be analyzed by a panelist so as to evaluate their acceptability

The extracted sugar cane juice was sterilized and allowed to cool after which it was divided into three batches for the three yeast strains inoculation. This was allowed to ferment to completion after which they were further subdivided into three batches for unflavored, banana flavored and pineapple flavored wines.

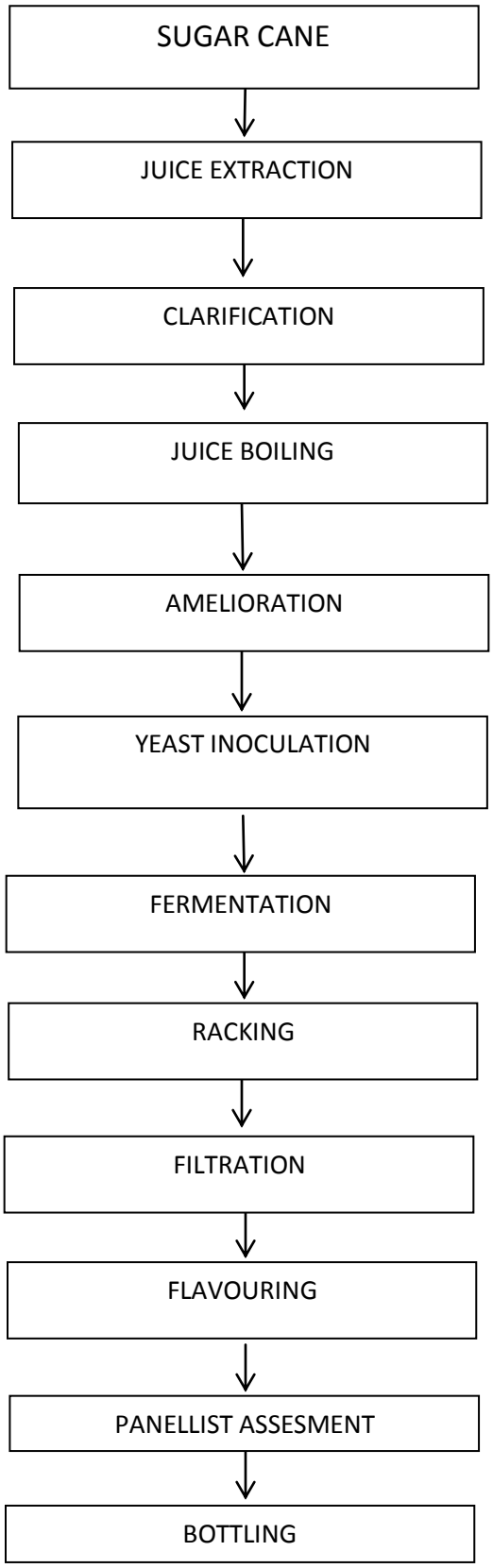
The flavored were allowed to mature after which assessment by a panelist of 20 people was carried out using a 7 point hedonic scale for evaluation of product appearance, flavor and aroma, taste and overall acceptability.

The three most acceptable wines were further assessed to determine the most preferred among them.



The data obtained from the panelist assessment was subjected to statistical analysis of variance to determine the most acceptable of wine products .

2.1 PROCESS FLOW DIAGRAM



2.2 MATERIALS

Raw sugarcane

Yeast strains;

- Brewer's yeast – EABL
- Muratina yeast
- Baker's yeast

Fruit flavors

- Banana
- pineapple

Clean water

pH meters

Crushers.

Sugar

Distiller

Alcohol meter

Refractometer

Tartaric acid

Phenolphthalein indicator

Knives

Beakers

sugar

NaOH 0.1N

Clean water

Fermenting vessels

Burettes and Pipettes

2.3 METHODOLOGY

i) Extraction of juice - Raw sugarcane juice was obtained through extraction by pressing of crushed peeled cane.

ii) Analysis of the juice obtained for;

- pH determination
- Total acidity- titratable acidity.
- Sugar content- brix

iii) The juice was then boiled to sterilize it and amelioration- to adjust the sugar content and the titratable acidity since these are crucial for good wine.

iv) The juice was subdivided into 3 batches and inoculated with the yeast strains for fermentation at 14- 18^0c.

iv) After completion of fermentation the wines were further subdivided into three groups for each batch for aromatization by addition of fruit flavors – banana, pineapple and the unflavored. These were then transferred into a chilling room for maturation.

v) Analysis of wine and assessment of acceptance by a panelist.

- Fixed acidity- total acidity minus fixed acidity
- pH determination
- total acidity- titratable acidity
- Alcohol content

2.4 ANALYTICAL METHODS

i.) Ph

This was determined by use of a pH meter.

ii.) Titratable acidity

This was obtained by diluting a 10 ml sample with water and titrating it against 0.1 N NaOH using a phenolphthalein indicator. The volume of NaOH used was noted at the endpoint and TA calculated as a percentage using malic acid constant

$$\frac{\text{Volume of NaOH(ml)}}{\text{Volume of sample}} \times 0.75$$

iii.) Determination of total soluble solids

This was by use of a hand refractor meter and the results expressed in degree brix

iv.) Alcohol content

100ml of wine was diluted with distilled water. This was distilled to 100ml distillate. An alcohol meter was then immersed into the distillate in a measuring cylinder to give the alcohol content.

3.0 RESULTS

3.1 LAB ANALYSIS

i) Sugarcane juice analysis

Parameter	Value
pH	5.65
Titratable acidity	0.075%
Sugar content degree brix	13.4 %

ii) **Ameliorated sugar cane juice**

Parameter	Value
pH	3.95
Titratable acidity	0.55%
Sugar content degree brix	23 %

3.1.1 WINE ANALYSIS

i) **Muratina wine analysis**

Parameter	**Value**
pH	3.01
Titratable acidity	1.19%
Sugar content degree brix	3%
Alcohol content	10 % v/v

ii) **Brewer's yeast wine**

Parameter	**Value**
pH	2.76
Titratable acidity	0.74%
Sugar content degree brix	3.4%
Alcohol content	12%

i) **Baker's yeast wine**

Parameter	**Value**
pH	3.45
Titratable acidity	0.64%
Sugar content degree brix	2.8%
Alcohol content	13.4 % v/v

3.2 SENSORY ANALYSIS RESULTS

A total of 20 panelists were provided with the wine samples and asked to evaluate using a 7 point hedonic scale for evaluation of product appearance, flavor and aroma, taste and overall acceptability with scores as below;

7= Like extremely

6= like very much

5= Like slightly

4= neither like nor dislike

3= Dislike slightl

2= Dislike very much

1= Dislike extremely

The scores were recroded as below;

i) Muratina yeast wine

SENSORY ATTRIBUTE	**Sample**	**Hedonic scale scores**						
		7-Like extremly	6-Like moderately	5-Like slightly	4-Neither like nor dislike	3-Dislike slightly	2-Dislike moderately	1-Dislike extremely
Taste	**Unflavored**	**0**	**2**	**5**	**5**	**4**	**4**	**0**
	Banana flavored	*10*	*6*	*1*	*1*	*1*	*1*	*0*
	Pineapple flavored	**4**	**10**	**3**	**0**	**2**	**1**	**0**
Flavor and aroma	**Unflavored**	**0**	**1**	**1**	**3**	**11**	**4**	**0**
	Banana flavored	*9*	*8*	*3*	*0*	*0*	*0*	*0*
	Pineapple flavored	**2**	**7**	**8**	**0**	**3**	**0**	**0**
Product apperance	**Unflavored**	**0**	**1**	**3**	**6**	**8**	**2**	**0**
	Banana flavored	*7*	*11*	*1*	*1*	*0*	*0*	*0*
	Pineapple flavored	**1**	**6**	**8**	**2**	**2**	**1**	**0**
Overall Acceptability	**Unflavored**	**0**	**1**	**4**	**9**	**2**	**4**	**0**
	Banana flavored	*7*	*6*	*4*	*2*	*1*	*0*	*0*
	Pineapple flavored	**1**	**11**	**3**	**2**	**1**	**2**	**0**

Brewers yeast wine

SENSORY ATTRIBUTE	Sample	Hedonic scale scores						
		7-Like extremly	6-Like moderately	5-Like slightly	4-Neither like nor dislike	3-Dislike slightly	2-Dislike moderately	1-Dislike extremely
Taste	**Unflavored**	**0**	**2**	**7**	**8**	**3**	**0**	**0**
	Banana flavored	9	5	5	1	0	0	0
	Pineapple flavored	**6**	**9**	**4**	**1**	**0**	**0**	**0**
Flavor and aroma	**Unflavored**	0	3	4	9	4	0	0
	Banana flavored	***9***	***6***	***4***	***1***	***0***	***0***	***0***
	Pineapple flavored	**4**	**7**	**6**	**2**	**1**	**0**	**0**
Product apperance	**Unflavored**	**0**	**6**	**8**	**4**	**2**	**0**	**0**
	Banana flavored	*13*	*5*	*2*	*0*	*0*	*0*	*0*
	Pineapple flavored	**0**	**8**	**8**	**2**	**2**	**0**	**0**
Overall Acceptability	**Unflavored**	**0**	**2**	**6**	**8**	**4**	**0**	**0**
	Banana flavored	*10*	*7*	*1*	*2*	*0*	*0*	*0*
	Pineapple flavored	**5**	**5**	**6**	**2**	**2**	**0**	**0**

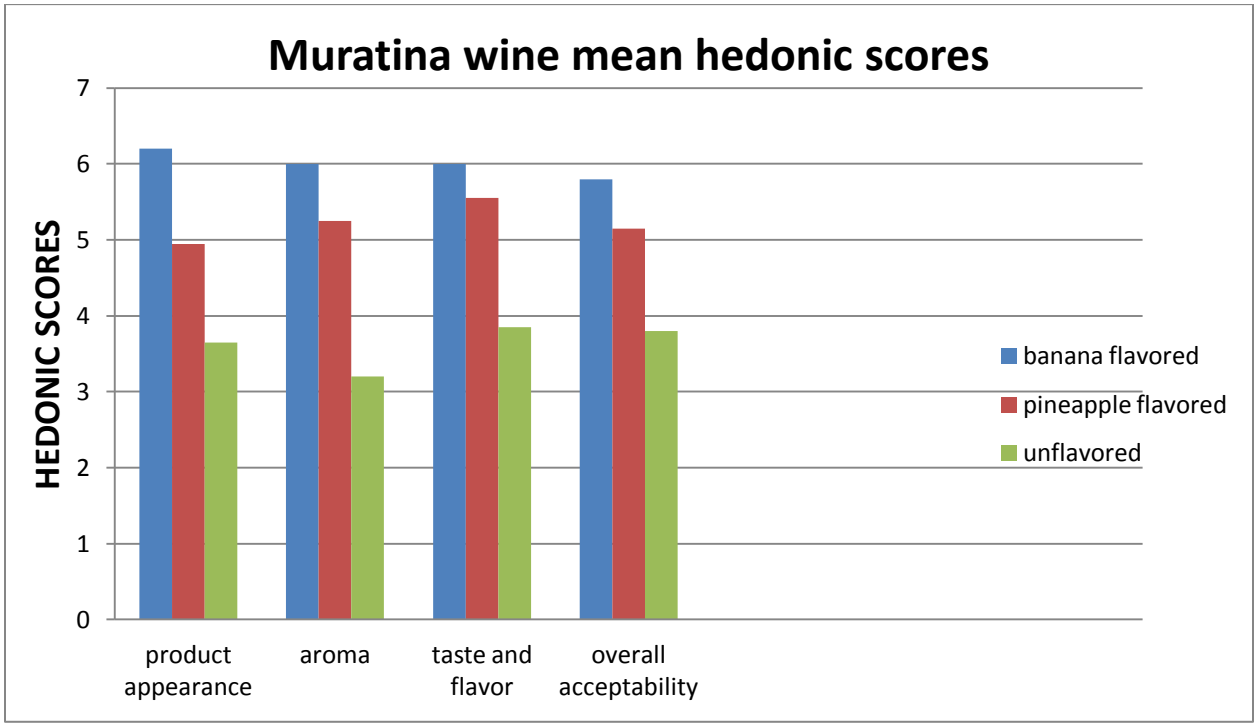
Bakers yeast wine

SENSORY ATTRIBUTE	Sample	Hedonic scale scores						
		7-Like extremly	6-Like moderately	5-Like slightly	4-Neither like nor dislike	3-Dislike slightly	2-Dislike moderately	1-Dislike extremely
Taste	**Unflavored**	2	4	8	3	1	2	0
	Banana flavored	8	7	5	0	0	0	0
	Pineapple flavored	3	7	5	2	3	0	0
Flavor and aroma	**Unflavored**	**1**	**5**	**7**	**6**	**1**	**0**	**0**
	Banana flavored	*11*	*6*	*3*	*0*	*0*	*0*	*0*
	Pineapple flavored	**4**	**11**	**4**	**1**	**0**	**0**	**0**
Product apperance	**Unflavored**	**2**	**4**	**6**	**6**	**2**	**0**	**0**
	Banana flavored	*11*	*6*	*3*	*0*	*0*	*0*	*0*
	Pineapple flavored	**3**	**10**	**6**	**1**	**0**	**0**	**0**
Overall Acceptability	**Unflavored**	**1**	**3**	**10**	**4**	**2**	**0**	**0**
	Banana flavored	*7*	*9*	*3*	*1*	*0*	*0*	*0*
	Pineapple flavored	**3**	**8**	**7**	**1**	**1**	**0**	**0**

3.3 TABLE OF MEANS AND ANOVA

i) Muratina wine

VARIATE	Product appearance			Aroma			Taste and flavor			Overall acceptability		
Sample	B	P	U	B	P	U	B	P	U	B	P	U
MEAN	6.20	4.95	3.65	6.00	5.25	3.20	6.00	5.55	3.85	5.80	5.15	3.80
L.S.D	0.755			0.653			0.878			0.800		



Analysis of variance

i.) VARIATE: AROMA

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	84.033	42.017	29.59	<.001
Residual	57	80.950	1.420		
Total	59	164.983			

i) VARIATE: PRODUCT_APPEARANCE

Source of variation	**d.f.**	**s.s.**	**m.s.**	**v.r.**	**F pr.**
TREATMENT	2	65.033	32.517	30.53	<.001
Residual	57	60.700	1.065		
Total	59	125.733			

ii) VARIATE: TASTE_AND_FLAVOR

Source of variation	**d.f.**	**s.s.**	**m.s.**	**v.r.**	**F pr.**
TREATMENT	2	51.433	25.717	13.39	<.001
Residual	57	109.500	1.921		
Total	59	160.933			

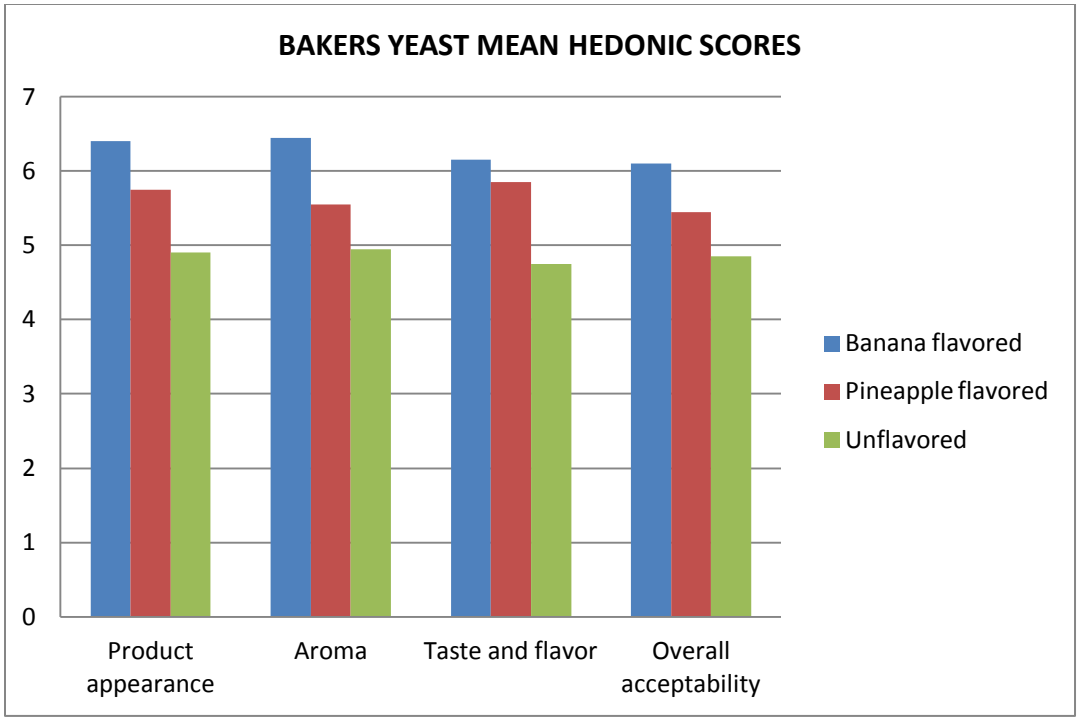
iii) VARIATE: OVERALL_ACCEPTABILITY

Source of variation	**d.f.**	**s.s.**	**m.s.**	**v.r.**	**F pr.**
TREATMENT	2	41.633	20.817	13.05	<.001
Residual	57	90.950	1.596		
Total	59	132.583			

ii) BAKERS YEAST WINE

Table Of Means

VARIATE	**Product appearance**			**Aroma**			**Taste and flavor**			**Overall acceptability**		
Sample	**B**	**P**	**U**	**B**	**P**	**U**	**B**	**P**	**U**	**B**	**P**	**U**
MEAN	6.40	5.75	4.90	6.45	5.55	4.95	6.15	5.85	4.75	6.10	5.45	4.85
L.S.D (0.05)	0.583			0.598			0.817			0.667		



Analysis of variance

i.) Variate: Product Appearance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	22.6333	11.3167	13.34	<.001
Residual	57	48.3500	0.8482		
Total	59	70.9833			

ii.) Variate: Aroma

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	22.8000	11.4000	12.78	<.001
Residual	57	50.8500	0.8921		
Total	59	73.6500			

iii.) Variate: Taste_And_Flavor

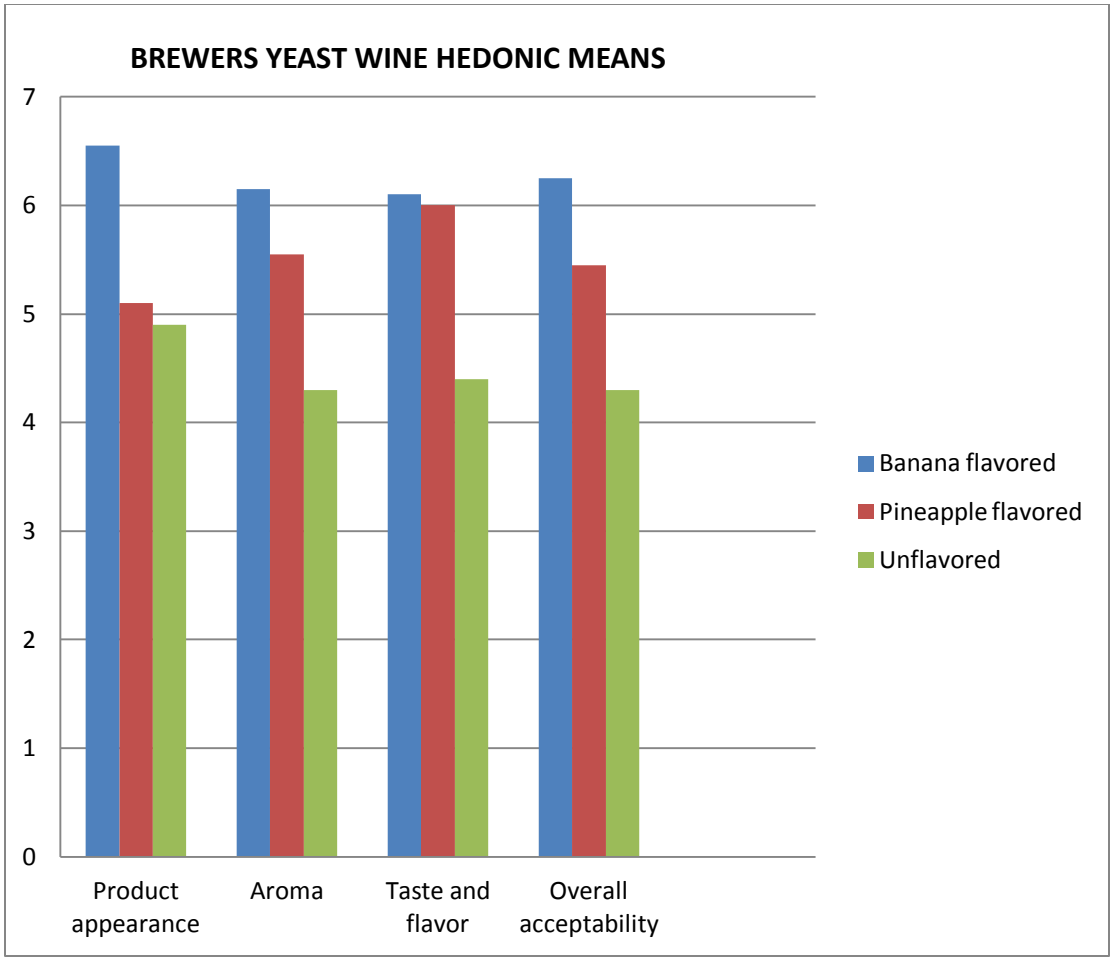
Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	21.733	10.867	6.53	0.003
Residual	57	94.850	1.664		
Total	59	116.583			

iv.) Variate: Overall Acceptability

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	15.633	7.817	7.04	0.002
Residual	57	63.300	1.111		
Total	59	78.933			

iii) BREWERS YEAST WINE

VARIATE	Product appearance			Aroma			Taste and flavor			Overall acceptability		
Sample	**B**	**P**	**U**	**B**	**P**	**U**	**B**	**P**	**U**	**B**	**P**	**U**
MEAN	6.55	5.10	4.90	6.15	5.55	4.30	6.10	6.00	4.40	6.25	5.45	4.30
L.S.D	0.560			0.637			0.573			0.676		



Analysis of variance

i) Variate: Product Appearance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	32.4333	16.2167	20.75	<.001
Residual	57	44.5500	0.7816		
Total	59	76.9833			

ii) Variate: Aroma

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	35.633	17.817	17.60	<.001
Residual	57	57.700	1.012		

Total 59 93.333

iii) Variate: Taste_And_Flavor

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	36.4000	18.2000	22.26	<.001
Residual	57	46.6000	0.8175		
Total	59	83.0000			

iv) Variate: Overall_Acceptability

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	38.433	19.217	16.88	<.001
Residual	57	64.900	1.139		
Total	59	103.333			

3.3 DETERMINATION OF THE MOST ACCEPTABLE WINE.

The banana flavored wine was the most accepted among the three samples of each batch. A sample of each of the three was given to a panelist of 20 and they were asked to evaluate on the most acceptable based on taste and mouth feel. The scores were as below;

Tables of means

Variate: OVERALL_ACCEPTABILITY

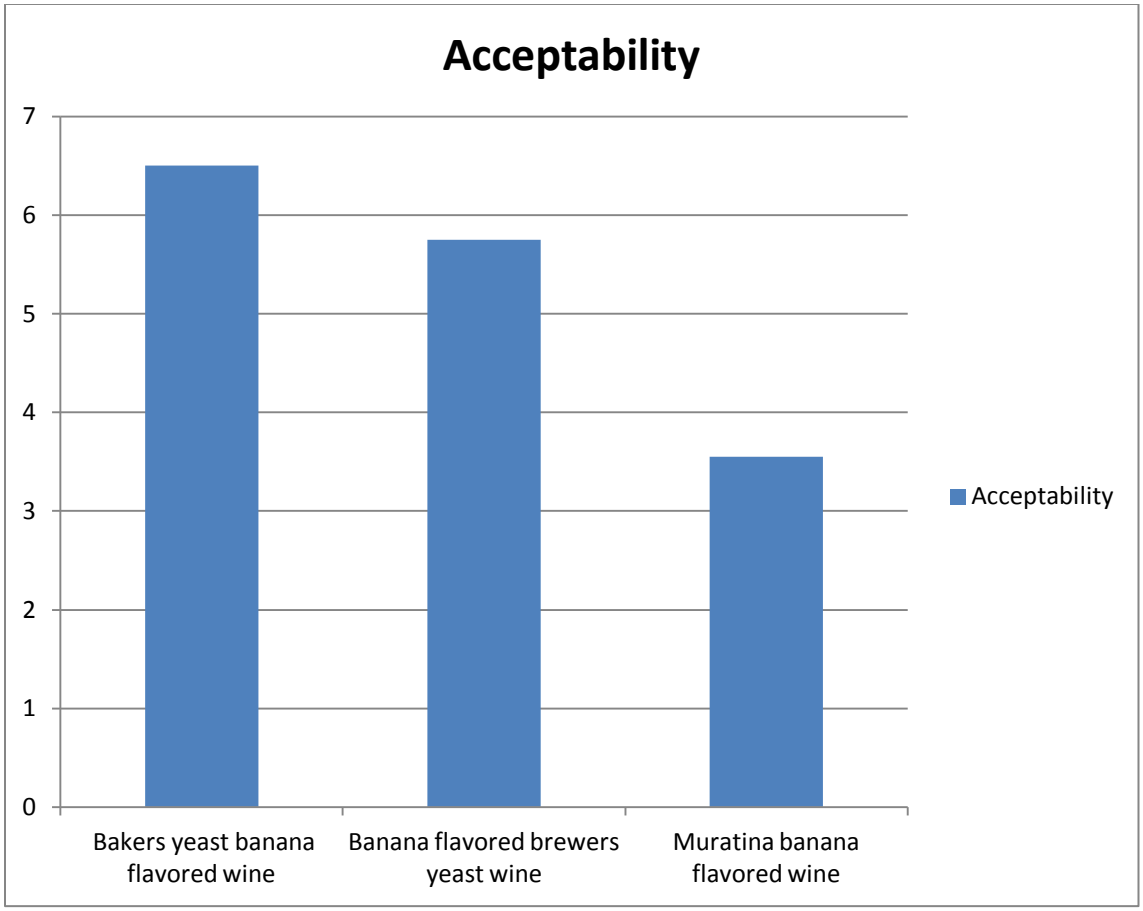
Sample	Mean
Bakers yeast banana flavored wine	6.50
Muratina banana flavored wine	3.55
Banana flavored brewers yeast wine	5.75

l.s.d. 0.615

Analysis of variance

variate: most acceptable wine

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	2	94.0333	47.0167	49.91	<.001
Residual	57	53.7000	0.9421		
Total	59	147.7333			


Acceptability
7
6
5
4
3
2
1
0
Bakers yeast banana flavored wine
Banana flavored brewers yeast wine
Muratina banana flavored wine
Acceptability

4.0 DISCUSSION

From the tests conducted it was established that bakers yeast had the best fermentability characteristics. This is as a result of the high alcohol content as compared to the other two strains. The wine had the least titratable acidity besides a high pH which shows that little sugar had been converted into acids.

Muratina yeast had the least alcohol content and the highest titratable acidity. This is due to conversion of some of the sugar into gluconic acid. The acid lowers the pH and reduces the wine's palatability.

The brewers yeast wine also had a significantly high acidity as compared to that in bakers yeast though higher alcohol content.

In all cases there the panelists had a preference of the flavored wines to the unflavored. The banana flavored wine had the most acceptability in all samples and also had higher scores in the sensory attributes tested. This was followed by the pineapple flavored with unflavored wines scoring the least in overall acceptability.

The banana flavored wines had much stronger aroma and flavor as compared to the pineapple flavor which wasn't as strong. The latter also had stronger colour which was retained by the products increasing products appeal in appearance.

The banana flavored bakers yeast wine was the most preferred by the panelist. This may be attributed to its low acidity compared to the other two. The muratina wine was quite sour due to too high acid concentration. This reduces the wine's palatability.

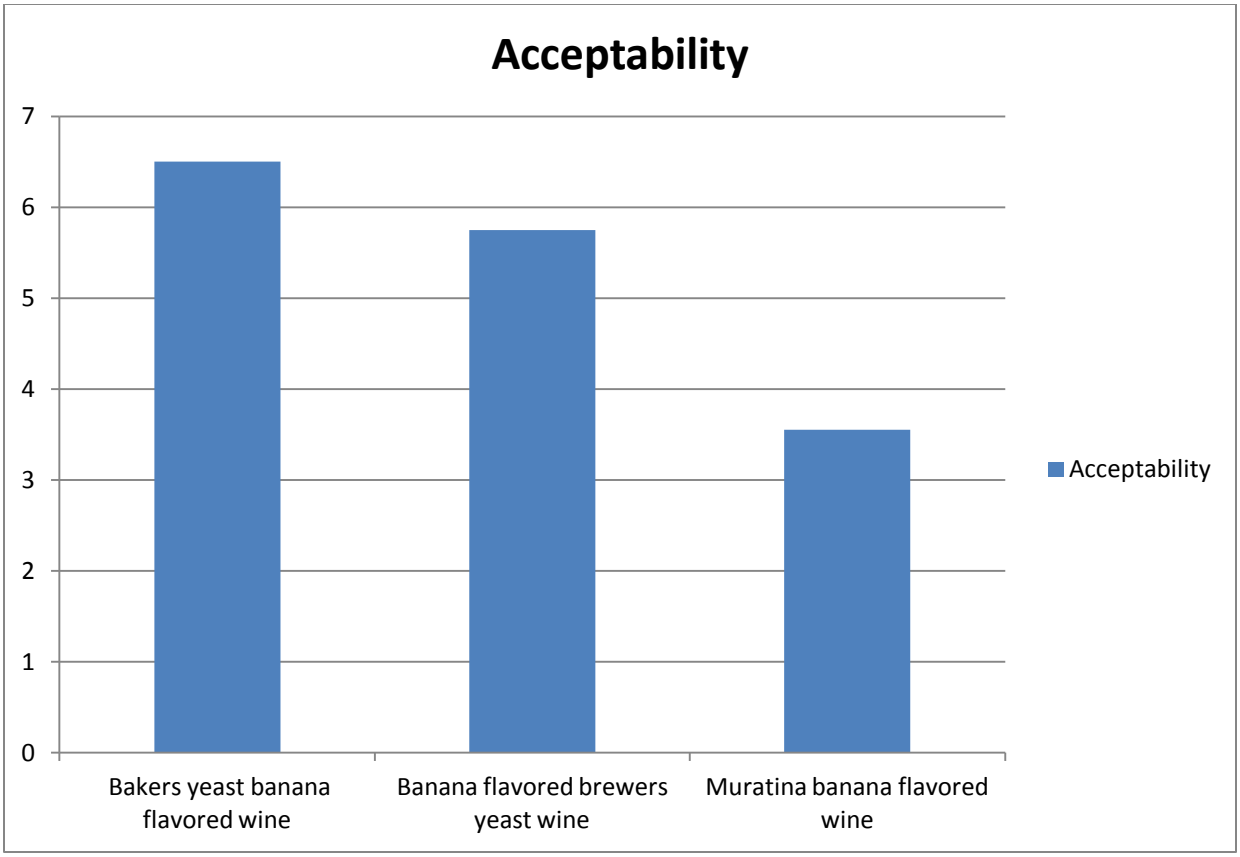
Interpretation of the anova for the most acceptable wine

From the anova analysis there was a significant difference between the means of the hedonic scores since the calculated V.R was higher than the tabulated ratio at 5% probability.

The flavored wine had a higher preference although there was also a significant difference in the bakers and brewers yeast wines.

The banana flavored bakers yeast wine had the highest mean scores hence was the most preferred. This may be due to a lower acidity as compared to the brewers yeast wine therefore superior in flavor.

Sample	Mean
Bakers yeast banana flavored wine	6.50
Muratina banana flavored wine	3.55
Banana flavored brewers yeast wine	5.75



Analysis of variance

Variate: Overall_Acceptability

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.(α=0.05)
Treatment	2	94.0333	47.0167	49.91	<.001
Residual	57	53.7000	0.9421		
Total	59	147.7333			

From the anova analysis there was a significant difference between the means of the hedonic scores since the calculated V.R was higher than the tabulated ratio at 5%.

The flavored wine had a higher preference although there was also a significant difference in the bakers and brewers yeast wines.

The banana flavored bakers yeast wine had the highest mean scores hence was the most preferred. This may be due to a lower acidity as compared to the brewers yeast wine.

5.0 CONCLUSION

The sugar cane juice was successfully fermented to wine using the three yeast strains. It was found out that bakers yeast had the best fermentability resulting to the best wine. The fruit flavoured wines were significantly preferred at ($P \leq 0.05$) over the plain product in all the three samples tested. This indicated that the elaboration of wine-like beverages is a good alternative use for sugarcane juice.

The objectives of this study were therefore achieved.

6.0 RECOMMENDATIONS

- Sugarcane juice is a good substrate for production of high quality wine. Since its easily available there is need for value addition through fermenting it into an alcoholic beverage.

- Muratina brew that is available locally is usually too acidic due to the acidity produced by the muratina yeast. The producers should be advised to use other yeast strains with better fermentability characteristics. This will result to high quality beverages that are much more acceptable to many consumers.

- Flavored wine is much more acceptable than unflavored ones hence need to research more on flavors that can increase consumer appeals to wine products.

7.0 REFERENCES

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